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TO EAT OR TO HEAT:
ARE ENERGY BILLS SQUEEZING PEOPLE'S SPENDING?

by Andrea Colabella*, Luciano Lavecchia§, Valentina Michelangeli* and Raffaella Pico*

Abstract

This paper presents an assessment of the energy price shocks that hit Italian households starting in mid-2021 and their impact on households' financial vulnerability. First, we estimate the price elasticity of electricity and heating demand and compute the variation between 2020 and 2022 within the framework presented in Faiella and Lavecchia (2021b). Second, we study how those variations affected households' financial vulnerability, based on an extension of the modelling strategy proposed by Faiella et al. (2022). Our results indicate that, if energy price elasticity is not duly accounted for, financial vulnerability rises excessively on the heels of an energy price upsurge. In contrast, when consumption rebalancing within a dynamic microsimulation model is taken into account, financial vulnerability remains rather low and in line with supervisory data. While the risks for financial stability associated with energy shocks are therefore limited, this occurs at the of expense of household consumption and welfare.

JEL Classification: C1, G5, Q41, Q54, Q58.
Keywords climate stress test, financial vulnerability, inflation, demand elasticity.
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* Bank of Italy – Directorate General for Economics, Statistics and Research - Financial Stability Directorate
§ Bank of Italy - Climate Change and Sustainability Hub

1 Introduction

At the beginning of 2021,[1] energy prices rose on the heels of a combination of supply and demand factors.[2] This structural increase was compounded by the Russian invasion of Ukraine on 24 February 2022, which resulted in an abrupt spike in energy prices on the global markets similar to that observed during the oil shocks of the 1970s.

The increase in global energy prices hit Italy, like other countries. Moreover, Italy's heavy reliance on energy imports makes it especially vulnerable to energy price shocks. Almost half of the electricity in 2021 and 60 per cent of all space heating in Italy was produced by burning natural gas, which, in the final months of 2021, was mostly imported (and mainly from Russia).[3] In 2022, gas and electricity prices on the Italian markets skyrocketed, reflecting uncertainties about the continuity and security of the supply stream due to the increasing Russian threats to Ukraine in late 2021 and the ensuing all-out war.[4] The energy shocks have had both direct and indirect effects on inflation: in the fourth quarter of 2022 the contribution to headline inflation was in the order of 60 per cent, and the contribution to core inflation between 20 and 50 per cent (Neri et al., 2023).

The abrupt price increases struck households unevenly, with those that spend a greater share of their budget on items that were more heavily impacted by the surging prices or with a higher average propensity to consume suffering the most (Curci et al., 2022; Faiella and Lavecchia, 2022; Guan et al., 2023). By eating away at households' purchasing power, the price hikes ultimately reduce disposable income, hampering households' ability to repay their debts. Depending on the amount of strain placed upon families, they could become more financially vulnerable and risks to financial stability could materialize.

[1]We would like to thank Alessio Anzuini, Andrea Bonfatti, Nicola Curci, Alessio De Vincenzo, Ivan Faiella, Giovanni Guazzarotti, Sara Meservey, Patrizio Pagano, Sabrina Pastorelli, Corrado Pollastri, Gwyneth Schaefer and Luigi Federico Signorini. The views expressed herein are those of the authors and do not necessarily reflect those of the Bank of Italy

[2]IEA, "What is behind soaring energy prices and what happens next?", commentary, 12 October 2021.

[3]At the end of 2021, Italy's natural gas imports from Russia accounted for about 40 per cent of the total, standing at just slightly less than 29 billion cubic meters.

[4]The surge in final energy prices, driven by spikes in import prices of natural gas, affected also the trade balance, with an energy trade deficit peaking at 5.4 per cent of GDP in 2022, the second-highest on record since 1981; the trade balance deterioration (3 percentage points of GDP) was slightly larger than those observed after the oil shocks of the 1970s (Romanini and Tosti, 2023).

This paper aims to analyse to what extent energy price hikes affect the financial vulnerability of Italian households. To this end, it collects three different strands of literature: the first one relates to the analysis of households' financial vulnerability within microsimulation models; the second one refers to the uneven effect of surging energy prices on households' standards of living, depending on their characteristics and propensity to consume; the third relates to estimates of energy demand and price elasticity to quantify the impact of energy shocks on households' consumption bundles.

Understanding how household energy markets work in Italy and which data are available to use is key to laying the ground for the analysis.

Retail gas and electricity markets both have a two-tier structure. In each segment the price of the energy component is determined according to specific rules, set separately for each market.[5] In greater detail, on the regulated market (*Mercato di Maggior Tutela*), the price of the energy component is set by the Italian Regulatory Authority for Energy, Networks and the Environment (*Autorità di Regolazione per Energia Reti e Ambiente* - ARERA) and updated quarterly. On the free market (*Mercato Libero*), the energy price is determined by market rules. In this market contracts can have different price setting mechanisms and length.

Given this complex structure, determining the impact of the inflation shock on households is not straightforward as we lack granular information, including on contractual length and on the clauses for the price of the energy component paid by each household. Therefore, we have to rely on alternative data sources to fill in the void. We apply the price increase indistinctly to all households; the exercise, therefore, establishes by construction an upper bound for their financial vulnerability. The results can also be interpreted as stemming from a stress test.

Bearing this in mind, we first determine price elasticities of electricity and heating for Italian households; this is necessary to understand how households cope with rising energy prices and, consequently, with a possible reduction in disposable income. In order to do so, we apply an updated version of the methodology proposed by Faiella and Lavecchia (2021b) to estimate the

[5] At the end of 2020, the energy component accounted for only half of the final price of electricity paid by households, the other half Was made up of taxes, levies and distribution fees (for gas, the energy component accounts for an even smaller share, circa one-third). Taxes, levies and distribution fees are set by ARERA, while only the energy component is determined by the market.

energy demand and price elasticities for Italian households. We use a quasi-panel approach as in Deaton (1985) to estimate price elasticities for 36 different household groups or strata using the Italian Household Budget Survey (HBS). Therefore, when an electricity or heating price shock hits the economy, all the households adjust their consumption bundle accordingly. The adjustment is, however, stratum-specific (although we apply a stochastic adjustment at the household level) and reflects households' characteristics and consumer preferences on the item shocked prevailing at each level.

To measure the effects of the energy price shocks on households' financial vulnerability, we first combine the consumption adjustment calculated above with microdata from the Bank of Italy's 2020 Survey on Household Income and Wealth (SHIW) using the 36 strata as merging keys. This new dataset allows us to calculate households' disposable income (adjusted using the information at the subgroup level) which reflects changes in consumption induced by the energy price shocks. We hold that household disposable income diminishes proportionately to the increase in energy expenditure, if any. Households' ability to repay their debt is affected by the reduced disposable income.

To dig further into the issue of financial vulnerability of households in Italy, we exploit to their full extent the microsimulation models developed at the Bank of Italy (Michelangeli and Pietrunti, 2014; Attinà et al., 2020; Faiella et al., 2022) and we extend them to take into account the changes in consumption. We run the simulations to check for financial vulnerability over the period 2020-2023 and introduce the energy-induced shocks (via the adjusted income) to take into account the recent surge in energy-related inflation.

We compare the evolution of households' vulnerability both in the absence and in the presence of behavioural responses/consumption adjustments (i.e. perfect inelastic demand or no elasticity),[6] to respond to energy inflation shocks. We apply these settings in three different price scenarios, compared with a baseline case where there are no energy-induced price shocks. In the remaining three cases, where the price shocks are at play, we use three different sources

[6]Excluding behavioural responses is a rather common, albeit counter-intuitive, assumption across microsimulation models. See UPB 2022; Istat 2022; Curci et al. 2022. Moreover, in 2022 households' electricity demand decreased by 3.6 per cent compared with 2021 and by 4.6 per cent compared with 2020, while households' natural gas demand fell by 9.5 and 1.7 per cent, respectively, following the price upsurge.

to measure the energy price increase observed between 2020 and 2022, and we apply them to all of the households: regulated market tariffs (*Mercato di Maggior Tutela*), the electricity and natural gas components of the NIC Index (Istat's consumer price index for the entire national community), and the weighted average unit cost of energy from Eurostat. The change in the final price of electricity (natural gas) between the average for 2020 and the average for 2022 was 172 (92) per cent according to the first source (regulated market tariffs), 142 (109) per cent according to the second source (NIC index), and 46 (47) per cent according to Eurostat. In absolute terms, which we feed into the model, this equates to an increase between 0.11 (Eurostat) and 0.60 (NIC) €/kWh for electricity and between 10.9 (Eurostat) and 48.9 (NIC) €/Gj for natural gas, with regulated market tariffs as a mid-point.

We start our exercise by running a series of static simulations, limiting our focus to households in the year of the last SHIW (i.e. 2020) and applying the cumulative energy price variation (in absolute terms) to reduce disposable income for the 2020-22 period, with and without considering price elasticity. We are therefore testing what would have happened to households' financial vulnerability if energy price shocks had been front-loaded and at the economic conditions registered in 2020, including disposable income, consumption, consumer credit, mortgages and interest rates. In the baseline scenario (before any energy price change), the share of vulnerable households in the population is 1.45 per cent and their debt (debt at risk) is 9.19 per cent of households' total financial obligations.

If households do not re-adjust their consumption choices after the energy price upsurge (i.e. assuming perfect inelastic demand or quantity invariance), energy expenditure rises proportionately. This leads to a proportionate decrease in disposable income and a consequent increase in financial vulnerability. We find that the largest growth in vulnerability was in respect of the NIC index and regulated market increases, both of which record much higher price spikes than Eurostat's, with the share of vulnerable households rising to 1.83 per cent (+ 0.38 percentage points) and debt at risk to 10.72 per cent (+1.53 percentage points). While such increases may appear to be low, they are not: they mark a 26 and 17 per cent increase, respectively, from the baseline. This rise in vulnerability, however, does not correlate well with other financial evidence, according to which the new non-performing loan rate does not spike following the energy price shock (Bank of Italy, 2023). In order to properly assess the evolution of financial vulnerability, it is therefore crucial to take into account households' reaction and consumption rebalancing.

We, therefore, extend our static setup to include energy price elasticities. In general, the price shock per se does not trigger a rebalancing in households' consumption choices; to get there, size matters. The largest increase in vulnerability occurs if all of the households are on the regulated market (+0.13 percentage points): the energy price upsurge triggers an increase in household energy consumption, though is smaller than in the case where there is no behavioural response, so disposable income and financial vulnerability raise less. In this case, the share of vulnerable households increases to 1.58 per cent and the share of debt at risk to 10.32 per cent. Applying the Eurostat price variation leads to more muted increases in both the share of vulnerable households and that of their debt, which rise to 1.47 and 9.25 per cent respectively.

Moreover, unlike the cases with null elasticity, financial vulnerability remains about the same as in the baseline scenario if all of the households experience the energy changes as measured by the NIC Index (the greatest variations). The increase in energy prices induces households to revisit their consumption choices, slashing the quantities consumed and limiting the impact on disposable income and, therefore, on financial vulnerability.

Applying a biannual energy variation to households in the last available year of the SHIW (2020) may, however, be inadequate. Macroeconomic variables may impact households' ability to repay their loans, and, consequently, their willingness to adjust their consumption. We exploit, to their full extent, microsimulation models where income, debt and consumption evolve over time reflecting macroeconomic data and projections (dynamic model).[7] At the same time, at the household level, the mechanism at work remains unchanged: facing price increases, households decide to re-adjust their consumption so that disposable income drops only limitedly. Hence, financial vulnerability is barely affected. In general, energy price variations are subdued in the years 2020-2021, while they are more marked in 2021-2022.

Throughout all the scenarios under consideration, the share of vulnerable households and the debt at risk appear to be very similar to those prevailing in the baseline scenario. This

[7] The historical evolution of income includes all the government measures implemented in 2021 - 2022 to mitigate inflation effects on household budgets.

confirms that vulnerable households adjust their consumption expenditure in such a way as to maintain the level of disposable income as stable as possible, so that it is also available for debt repayment.[8] Looking at the heterogeneity results, we find very minor differences across scenarios. We can thus conclude that households' vulnerability continues to be driven by macroeconomic variables other than energy price variations which have a limited impact. On the other hand, the muted impact could come at the cost of consumption reduction, thus lowering household' welfare.

While for the period 2020-22 we exploit existing data on energy price variations, for 2023 the data are limited. The only information available for both electricity and gas comes from the regulated market and refers to the first semester. According to this source, energy prices decline, driving a reduction in vulnerability. As a robustness exercise, we consider two alternative price evolution scenarios within the dynamic microsimulation model. In the first one, we assume a small energy price increase, similar to that observed in 2020-21; in the second one, we consider a more pronounced price evolution, equal to that for the years 2021-22. As for the results obtained for the period 2020-22, the two scenarios bring about similar results: financial vulnerability is driven by macroeconomic variables, i.e. interest rate rise and GDP variation.

This paper innovates the existing literature along three dimensions. To the best of our knowledge, it is the first to take on board the effects of energy price increases via the correction in disposable income obtained by consumption elasticity in both the static and dynamic analyses of households' financial vulnerability. In other exercises, aimed at evaluating the effects of the recent price upsurge on Italian households along with the multi-pronged measures implemented by the Italian government to combat it, elasticities are set to be equal to zero, and no financial vulnerability analysis is performed (Curci et al., 2022; UPB, 2022; Istat, 2022). Secondly, the paper evaluates the effects of energy price increases on households' financial vulnerability, intertwining it with the evolution of macroeconomic variables, including mortgages and consumer credit to households. While the topic of the analysis of households' financial vulnerability partly aligns this work with that by Faiella et al. (2022), introducing the dynamic dimension allows us

[8] We rule out the possibility that the savings accumulated during the pandemic were used to trim debt (Colabella et al., 2023).

to have a richer interaction between the variables and to relax one of the hypotheses assumed therein. Thirdly, the paper merges several datasets. In fact, such data stem from an updated series for energy-related products (for the period 1997 – 2021) that makes it possible to calculate energy-demand elasticities based on observations that refer to both pre-pandemic and pandemic conditions; at the same time, by using the 2020 round of the SHIW, we can include the most recent households' debt variables available in the Italian survey, which also reflect the impact of the COVID-19 pandemic.

Finally, we would like to point out some caveats on the results obtained. First and foremost, the exercise is based on the assumption of partial equilibrium and does not include spillover effects; second, the time horizon we focus on is short, though this appears to be less of a concern at the current stage since the recent bout of energy-price inflation seems to be dissipating in the medium term.

The structure of the paper is as follows. Section 2 offers an overview of the existing literature on the topics. Section 3 describes our data and methodologies for simulating the energy shock; we also provide a discussion of estimated energy price elasticities. Section 4 shows the set of models used to assess how the energy shock affects households' financial vulnerability. Detailed results of the static exercise are presented in Section 5, which also includes some heterogeneity analyses. The results of the dynamic study are shown in Section 6. Section 7 concludes the paper and sets the future research agenda.

2 Literature review

This paper merges three different strands of literature. The first is related to energy price elasticity; the second refers to microsimulation models of households' financial vulnerability; the newest strand deals with the uneven impact of rising energy prices on households' standards of living.

Studies on the determinants of energy demand, especially electricity, are abundant and date back to several decades ago, with the seminal work of Houthakker (1951). Moreover, there are, literally, hundreds of estimates of price elasticity, although most of them are based on US data.

Espey and Espey (2004) report a meta-analysis of 36 papers, with more than 123 short-run and 96 long-run price elasticities estimates of residential electricity demand; in the short-run, price elasticity ranges between -2.01 and -0.004 (mean: -0.35) while in the long-run elasticity ranges between -2.25 and -0.04 (mean: -0.85). Labandeira et al. (2017) carry out a meta-analysis for a dozen *surveys* on energy demand, again with mixed results, depending on the fuel considered and time frame; as for electricity, elasticity is equal, on average, to -0.126 in the short run (-0.365 in the long run), while for natural gas it is equal to -0.180 in the short run (-0.684 in the long run). However, most of these studies are based on the United States, whose power sector is significantly different from Italy's, both in terms of market structure, prices and energy demand. The average American household consumes four times the amount of electricity consumed by a typical Italian household,[9] with a significant contribution of electricity for space heating (one third of all homes in the US,compared with an almost non-existing share in Italy).[10]

Estimates for energy demand price elasticity in the Italian case are few: Faiella (2011) finds that the effect of prices on the energy shares is negative for heating, while for electricity the effect is negative for the 1997-2004 period and positive for the 2005-2007 subsample. Bigerna (2012) observes that the price elasticity for electricity depends on the time of the day (due to the tariffs system in place up to 2016, encouraging off-peak use) and on the geographical zones, ranging between -0.03 and -0.10. Bardazzi and Pazienza (2019) observe that, with respect to the age of the head of the households, electricity demand is hump-shaped, reaching a peak when the head of a household is 50 years old, while natural gas demand keeps increasing with age, as the time spent at home increases. They also show that elasticities for electricity and natural gas (at the national level equal to -0.705 and -0.621 respectively) are higher in the Centre and the Southern regions. Faiella and Lavecchia (2021b), previously mentioned, using a quasi-panel approach, estimate the price elasticity for electricity and heating for 36 groups of Italian households in the short run (-0.44 and -0.54 on average for electricity and heating, respectively). Finally, Favero and Grossi (2023) analyzes a sample of bills from Veneto, finding that the price elasticity for natural gas demand from residential customers is quite rigid (around 0.5).

[9] "How much electricity does an American home use?", FAQ, US Energy Information Administration.

[10] For the US: "Highlights for space heating fuel in U.S. homes by state, 2020", FAQ, US Energy Information Administration.; for Italy: "Use of energy products in households: space heating", Eurostat.

Faiella and Lavecchia (2021b) is, to the best of our knowledge, the only paper to put forward a methodology to estimate the demand and elasticity of energy-related items and to analyse the effects on consumption of a carbon tax. The authors combine the microdata of the Italian HBS with several external sources. They use a quasi-panel approach and estimate the demand elasticity via an autoregressive distributed lag (ARDL) model. They run several regressions applying many different estimation techniques. In general, their results underscore that households' price elasticity is greater in the long run and for transport fuels and electricity.

Faiella et al. (2022) apply the methodology developed in Faiella and Lavecchia (2021b) to determine the extent to which different levels of carbon taxes affect the financial vulnerability of households and firms. While they take into account the effects of energy price increases on the consumption bundle of households (and on the energy expenditure of firms), they run a static exercise. They find that, within reasonable amounts of carbon tax, the vulnerability of households and firms is only barely hit by energy-related shocks.

On the microsimulation dimension, our benchmark models are those developed by Attinà et al. (2020) and Michelangeli and Pietrunti (2014) at the Bank of Italy. Such models simulate the evolution of financial vulnerability of Italian households starting from SHIW data reconciled with macro-variables. On the debt side, the data take on board any type of households' financial liabilities, i.e. mortgages and consumer credit.

As for the impact of rising prices on household income and the uneven impact on their standards of living, there has been a blossoming of literature in recent years. We have no aim to cover it all and we will limit ourselves to papers more strictly related to the topic.

Curci et al. (2022) evaluate the sharp rise in prices registered in 2021-22 on the purchasing power of different types of Italian households. The authors maintain that households consumption (in terms of quantities) remains unchanged (i.e., they assume setting price elasticity equal to zero) in the face of the 2021-22 inflation bout. They use survey microdata on household expenditures, along with the tax and benefit microsimulation model of the Bank of Italy (BIMic), to gauge the impact of the inflationary shock on the distribution of households' purchasing powers, while allowing government measures to kick in. They find that the government's measures mitigated the distributional impact of the inflationary shock. Such measures curtailed inflation on average by slightly less than 2 percentage points, with a relatively more significant reduction for low-income households.

Similar results are obtained by UPB (2022). They use a microsimulation model fed by Istat's Households Budget Survey (HBS) data, also taking into account fiscal and social contribution data. Like in Curci et al. (2022) price shocks - referring to the period between June 2021 and September 2022 - hit households' consumption bundles but do not have an impact on quantities (i.e., price elasticity is again set equal to 0). According to the simulations, the actual increase in households' expenses owing to inflation was contained thanks to the government measures. Such measures were also put in place to fight the regressive impact of the inflation shock; households belonging to the first income decile in terms of expenditure increase bear a much less burden than the average family. Also, it resulted in smaller increase in energy poverty (AA.VV., 2023).

Causa et al. (2022) provide a quantification of the impact of rising prices on households' welfare over the past years for ten OECD countries. Drawing on micro-based HBS and CPI data, their paper tries to identify which households are more exposed and vulnerable to the recent rise in inflation, with a focus on energy and, to a lesser extent, food price inflation. By using it as a measure of purchasing power resulting from changes in consumer prices underlying inflation, the authors find that the decline in households' purchasing power between August 2021 and August 2022 was driven by energy prices and is particularly relevant in Italy, among other countries. The plummeting of purchasing power has led to heterogeneity across countries and partly reflects differences in the rate of inflation, its diffusion across consumption items and the spending structure of the average household. Causa et al. (2022) also explore differences across household income groups and other relevant dimensions and find that the households most exposed to rising energy prices are low-income, senior and, in some countries, rural.

To assess the impact stemming from rising prices and interest rates on household debt affordability the Bank of England (2022) has produced a new cost of living adjusted debt-servicing ratio measure. The new measure adjusts income for taxes and an estimate of essential spending, which includes utility and council tax bills, housing maintenance, food and non-alcoholic beverages, motor fuels, vehicle maintenance, public transport and communication. However, consumption in the above-mentioned areas increases one-to-one with prices. The authors estimate that in 2022 the share of households with high cost of living adjusted debt service ratios (DSRs) on either their mortgage or consumer credit remained significantly below pre-global financial crisis peaks and they are not projected to increase substantially in 2023. This reflects government support measures relieving some of the pressure on household finances, particularly from the rise in living costs, in the near term.

So far household vulnerability has been evaluated in the face of aggregate shocks to income (i.e. a recession), interest rates (i.e. contractionary monetary policy) or a carbon tax. In what follows we will bring together the different abovementioned bodies of research to take into account the inflation impact (triggered by energy price shocks) on the households' consumption bundle and the ensuing consumer expenditure adjustment. This, in turn, has a bearing on household income and hence on financial vulnerability. To carry out this exercise, we modify household disposable income in a heterogeneous way across households exploiting energy price elasticities. To this end, we analyse how energy prices impact Italian households' consumption choices.

3 Data

3.1 Energy prices

Over the years, both gas and power markets have gone through in-depth changes reflecting legislative innovations. Until 1999, energy provision in Italy was supplied by state-owned enterprises, which operated in legal or actual monopoly regimes. Starting from the early-2000s, Italy transposed the so-called "first energy package" into law,[11] and initiated a process of liberalisation of the internal markets for electricity and gas, beginning with supply to large corporations. Since then, a slow process of market liberalization started and it is currently ongoing. However, as the production and distribution of electricity and gas were opened up to new entrants, the mechanism of final price determination for households was not left totally up to full competition (Stagnaro et al., 2020). Since 2009, households can choose between the regulated tariff, set up quarterly by the energy regulator (so-called "*Maggior tutela*"), or a price offered by suppliers

[11] Directive 96/92/EC ("first electricity Directive"), adopted in 1996, and Directive 98/30/EC ("first gas directive"), adopted in 1998.

in the free market. At the end of 2022, almost 70 per cent of the electricity and gas bought by households was supplied by operators in the free market, with the share in the regulated markets continuously declining. On top of that, the regulated markets are supposed to expire by early 2024, although deadlines have been postponed several times.

Unfortunately, there is no data on energy prices at the household level, a major drawback hindering all analyses in Italy. To explore the energy price variations, in this work we will use three different sources: 1) the regulated tariffs set by the energy regulator (*Maggior tutela*); 2) the electricity and natural gas components of the price index (NIC) produced by Istat, which is further disaggregated between regulated vs free market;[12] 3) the semi-yearly, weighted, average unit cost for electricity and natural gas, collected by Eurostat for each member state.

We focus on price changes observed between 2020 and 2022. In Table 1 we show the price variations for the aforementioned three sources (the regulated market, Columns 1 and 4); the energy components of the price index, the NIC (Columns 2 and 5); the average energy weighted unit cost from Eurostat (Columns 3 and 6). Price changes are computed both as cumulated variations (in percentage points) and as absolute variations (in €/kWh for electricity and €/Gj for natural gas[13]), for the overall 2020-22 period and each year (i.e., 2020-21 and 2021-22). All prices are in real terms (using the electricity and natural gas components of the HICP index for 2015 as the base year).[14] Moreover, given the high variability of prices, we compute the variations by taking yearly averages. In our model, we use the variations in absolute terms (€/kWh or €/Gj). As for the NIC, we apply the cumulated variations to the 2020 averages from Eurostat.

There is significant heterogeneity across sources. The price increases in the period 2020-2022

[12]The price indexes for the regulated market reflect the quarterly updates by ARERA to its tariffs, whilst the price indexes for the free market refer to new contracts only and, hence, apply to a fraction of customers, who have signed a new deal with an energy provider. More than 80 per cent of households on the free market have multi-year (the average length is two years), fixed prices contracts; therefore, such households are unaffected as long as their contracts do not expire. At the current juncture, information on contract length for households is unavailable.

[13]Natural gas covers, on average, 60 per cent of the space heating uses. Moreover, data on retail prices for the other energy vectors used for space heating (wood, pellet, district heating, LNG, gas cylinders, etc.) are unavailable, not even at aggregate level. Therefore, in the absence of better data, we will use (a strong assumption) the retail prices of natural gas for all the heating fuels (the remaining 40 per cent).

[14]This choice is made to isolate the inflation impact related to energy prices only.

for electricity range between 46 and 172 per cent (0.11 and 0.60 €per kWh), while for natural gas between 47 and 109 per cent (10.9 and 48.9 €per Gj). Price increases are more marked in 2021-22 (as a result of the Russian invasion of Ukraine) than in 2020-21. Overall figures from Eurostat set the lower bound (both as percentage and absolute variations), but they are not very far from those of the regulated market especially in 2021-22, while the figures from the NIC appear to be the upper bound.

3.2 Energy expenditure and price elasticities of energy demand

To estimate the demand price elasticity we need two data sources: the quantities consumed of a good and its prices. However, in the absence of microdata on energy quantities,[15] in this work we use the microdata on expenditure from the Italian HBS for the period 1997-2021.[16] The HBS collects information from about 20,000 households interviewed during different periods of the survey year.[17] As mentioned above, Faiella and Lavecchia (2021b) used HBS data to develop a microsimulation model of household energy demand. They estimate the short and long-run price elasticities of energy demand for electricity, heating and private transportation fuels, using the HBS, integrated with other (aggregated) sources of information on energy prices and calibrating the estimated quantities through official aggregated data. As the HBS is not a panel, the authors, following Faiella and Cingano (2015), use a *quasi*-panel approach (Deaton, 1985),[18] and estimate the demand elasticity for each subgroup exploiting the change over time of energy prices and demand fitting the following Auto-Regressive Distributed Lag (ARDL) model (see Greene 2008

[15] A centralized archive of electricity and natural gas consumptions from all Italian households and firms, the *Sistema informativo integrato* (SII), managed by Acquirente Unico, exists but is currently not available. As for other energy vectors commonly used for space heating (i.e., wood, pellet, LNG) a survey on households' energy consumption has been carried out in 2021 but the microdata are still not available.

[16] *Indagine sui consumi delle famiglie* for the years between 1997 and 2013 and the *Indagine sulla spesa delle famiglie* from 2014 to 2021.

[17] The data collection process is very accurate, involving a combination of personal and telephone interviews with weekly diaries or logs compiled by households and several quality checks.

[18] The *quasi*-panel approach compares the values of population subgroups classified in different stratum, formed according to their demographic characteristics (i.e. age, marital status, number of family components). The authors use the household classification provided by Istat, accruing to nine subgroups of households, observed across fourths of the equivalent expenditure distribution (e.g. households belonging to the fourth quartile of the equivalent expenditure distribution, are recorded as 4xx.). In total, there is information on 36 subgroups observed monthly between 1997 and 2021, for a total of 10,795 observations.

for further details):

$$logQ^z_{s,t} = \lambda_s logQ^z_{s,t-1} + \beta_s logP^z_t + \gamma_s logE_{s,t} + w + s + t + t^2 + \epsilon_{s,t} \quad (1)$$

where $Q^z_{s,t}$ is the fuel z consumed by stratum s in the month t, P^z_t is the average price of fuel z at time t, $E_{s,t}$ is the total expenditure of stratum s at time t, w and s are seasonal dummies, t and t^2 are time dummies, and β_s is the coefficient of interest, the (short-run) price elasticity. In our setting, we will build on the LS estimates available at stratum level, which will be fed into a model of households' financial vulnerability in Section 4.

The estimates of the elasticities are reported, joined with their standard error, in Table 2. On average, households' price elasticity is smaller for electricity than for heating; for a 1 per cent increase in price, electricity demand decreases, on average, by 0.44 per cent (0.54 for heating). Moreover, the elasticity of electricity demand decreases as households become richer (the opposite is true for heating). This is not surprising, as electricity is a merit good, with a demand that is more rigid compared to space heating which, in turn, is easier to module/adjust according to budget constraints.

Richer households exhibit higher heating elasticity as they usually have alternative heating systems (e.g. heating pumps) and/or better insulation. It follows that they have the means to react more to an increase in heating prices, by switching fuels or reducing (already high) thermal comfort. Also, households with 3 or more children are more sensitive to price increases across all the distribution, as well as poor singles, both for electricity and heating.

Discussion on price elasticities. As highlighted in Section 2, there is significant heterogeneity across estimates of price elasticities, depending on the energy vector, type of clients (residential vs. industrial) or time frame (short vs. long run) at stake. Moreover, most of the existing literature is based on analyses referred to the US, which, for several reasons, are not very comparable to Italy (where, on the contrary, evidence is scant) from a point of view of retail energy markets. This implies that it is very difficult to gauge whether our elasticity estimates are "too high" or "too low".

Moreover, Peersman and Wauters (2023), working on Belgium data, find that the energy price elasticity is significantly higher for price increases rather than price decreases, while it diminishes heavily for greater price hikes, like the ones recently experienced by Italian households.

Additionally, the energy price variations recorded in the period, and especially in 2020-22, are so large that they might have induced a structural break, i.e. households' responses might have become more elastic. Unfortunately, at the time of publication, the microdata for 2023 are not fully available[19] and we exploit, as a robustness check, data available for the previous years.

To cope with the lack of information on energy prices at the household level, we used the available sources discussed in section 3.1 and reported in Table 1. However, as previously pointed out, millions of households in Italy were provided electricity and natural gas (the main energy vector for space heating in Italy) at fixed prices when the price surge started (end of Q2-2021). While many of these contracts have expired over time and the supply of new fixed contracts almost disappeared over 2022, it is also true that for months, some households paid less for their electricity and natural gas in 2022 than in 2020 because of the government's interventions.[20]

All these assumptions do not come for free. Given the price variations and our estimates of price elasticities, the (estimated) overall demand for electricity falls, on average, by 40 per cent year-on-year, a decrease almost ten times larger than that based on ARERA (-3.6 per cent year-on-year in 2022). Similarly, heating demand falls up to 90 per cent under the NIC scenario (where prices increase the most) compared to a reduction of 9.5 per cent according to ARERA. While a fall in demand, following a price increase, is *prima facie* evidence of a behavioural response (and, therefore, works assuming fixed demand should be reconsidered), the differences cited above in decreased demand are striking. Only when the fully-fledged official microdata are available this puzzle will possibly be solved. Nevertheless, as the goal of this paper is to run a stress test exercise, our estimates are very good for capturing the worst case scenario.

[19] Only data from the regulated market are available for the first half of 2023.

[20] Between the second half of 2021 and 2022, the Italian government set up several untargeted measures to help (all) households. They reduced VAT for natural gas (from 22 to 5 per cent) and eliminated some levies from the electricity bill (which accounted for up to a quarter of the final price). On top of these, the authorities increased, both at the extensive and intensive margins, the targeted programs to assist poor households to foot their energy bills.

3.3 Data on income, debt and consumption

The household-level data used as a starting point of the microsimulation model to evaluate household vulnerability are from SHIW, which the Bank of Italy has been carrying out since the 1960s.[21]

Starting from the microeconomic data in the household survey the microsimulation model simulates dynamics for total income, amount of total debt and interest rates that are in line with the macroeconomic environment or with its forecasts according to the last projection.[22]

The starting point of the projection is the cross-section of the most recent SHIW wave, namely 2020.

Macro data come from several sources. First, we use disposable income (growth) from the national accounts (*Contabilità Nazionale*, CN), which includes imputed rents and is aimed at capturing the standard of living of households.[23] After plummeting in 2020 as a consequence of the repercussions of the Covid-19 pandemic, income rebounded in 2021 (its growth was 3.6 per cent) and accelerated further in 2022 (at 6.3 per cent); income expansion is projected to soften in 2023, but to remain moderately positive. Second, we make use of the historical evolution and projections of lending to households for house purchases and for consumer credit - which are from the Bank of Italy's statistical data warehouse. Mortgages growth was high in 2021 and 2022 (at around 5 per cent in both years) but it is expected to slow down sharply in 2023; a similar trend, although somewhat more subdued, is shown for consumer credit (granted by banks).[24] We use actual data and projections of the three-month Euribor obtained from futures contracts to recalculate payments of households holding a variable interest rate mortgage and those associated with new originations. At the same time, we exploit the 10-year IRS as a benchmark for fixed-rate new mortgages. While in 2021 the Euribor further declined to -0.547 per cent (annual average), it was slightly positive in 2022 (0.343 per cent) and is expected to

[21]The dataset contains detailed information on households' characteristics (e.g. number of household members, age, residence), income, debt (distinguishing between mortgage and consumer credit) and consumption. For a description of the survey, see Survey on Household Income and Wealth.

[22]For details on the projections of Bank of Italy see Bollettino economico 1/2023.

[23]By definition disposable income in 2021 and 2022 includes all the fiscal measures in favour of households aimed at staving off inflation effects on their financial balances, such as targeted transfers.

[24]Consumer credit growth was 1.0 and 2.9 per cent, respectively in 2021 and 2022, while a moderate slowdown is expected in 2023.

increase sharply in 2023. On average in 2021 the IRS stood at little more than zero per cent, but increased sharply in 2022 (to 1.9 per cent); for 2023 the IRS growth could be slightly lower. We finally exploit both HBS data to compute the change in consumption expenditure by stratum and the macroeconomic projections on yearly growth of final consumption from the internal Bank of Italy macroeconomic model to generate aggregate consumption dynamics in the model similar to those observed in the data. The yearly variations in final consumption are around 5 per cent in the year 2021-22 and are projected to be lower in 2023.

4 Setup of the financial vulnerability simulation

In this section, we build the modelling structure of our exercise. A household is defined as financially vulnerable if loan instalments to income exceeds 30 per cent and its income is below the median of the population. Financially vulnerable households are more likely to be late in their loan repayments by more than 90 days, which is the first stage of non-performing loans (Michelangeli and Rampazzi, 2016). This indicator is also highly correlated with the rate of new non-performing household loans[25] based on the Italy's Central Credit Register data. [26] For these reasons, vulnerable households should be closely monitored to gain some insight into the threats potentially posed to the stability of the financial sector.

As for households, vulnerability from a financial stability standpoint does not necessarily mean default but refers to possible difficulties in meeting financial obligations when a negative shock occurs. Many vulnerable households are solvable if economic conditions do not change, but they could move from a state of vulnerability to one of default if their ability to repay their debts is hindered by a negative shock. We thus aim to identify indebted agents who potentially could be problematic for their own selves (for instance, they could lose their homes) as well as

[25] The rate of the new non-performing households' loans is measured as the average of the annualized quarterly flows of adjusted non-performing loans in relation to the stock of loans at the end of the previous quarter net of adjusted non-performing loans (see, for instance, Bank of Italy 2016).

[26] The Central Credit Register (CR), managed by the Bank of Italy, is a database on household and firms' debts towards the banking and financial system. The CR is supplied with data that the participating intermediaries (banks, financial companies and other intermediaries) send in relation to loans and guarantees granted to their customers, to guarantees received from their customers and to loans or guarantees purchased from other intermediaries.

for the liquidity and solvability of financial intermediaries.

To analyse the problem at stake in a dynamic way, we need to make projections for several variables, namely mortgage and consumer credit instalments and debt, income and consumption (this latter variable is crucial for assessing the impact of a variation in energy prices).

4.1 Financial liabilities and income projections

Mortgages represent the main liability of Italian households and, consequently, household financial vulnerability is closely tied to changes in loan instalments associated with this type of debt. To predict mortgage loan instalments, we build on the work by Michelangeli and Pietrunti (2014) that compute the loan repayments exploiting the standard amortization formula and the household-specific debt characteristics available in the SHIW. [27] The scheduled total annual repayment $R_{q,i,t}$ for any mortgage type q (for instance, a household can have more than one mortgage), $M_{q,i,t}$, of household i at time t is given by:

$$R_{q,i,t} = M_{q,i,t}(1 + r_{y,i,t})^A * \frac{r_{q,i,t}}{(1 + r_{q,i,t})^A - 1} \quad (2)$$

where $r_{q,i,t}$ is the interest rate on debt $M_{q,i,t}$ and A is the residual duration.

Starting in 2014, consumer credit in Italy began skyrocketing and it was warranted to take properly into account any consumer loans in Bank of Italy's microsimulation model.[28] To this end, we rely on the approach proposed by Attinà et al. (2020), according to which the projection of consumer credit is achieved in three steps. In the first step, household participation in the consumer credit market is estimated by exploiting the following regression:

$$DC_{i,t} = \alpha_0 + \alpha_1 DC_{i,t-1} + \alpha_2 DM_{i,t-1} + \alpha_3 Dy_{i,t} + \alpha_4 Dur_{i,t} + e_{i,t} \quad (3)$$

[27] In addition to imposing some structure for the evolution of debt for existing mortgages, Michelangeli and Pietrunti (2014) present a way of introducing mortgage originations, which result from a pseudo-panel that builds on historical data and are adjusted to match the total growth in household debt available from macroeconomic forecasts.

[28] Attinà et al. (2020) show that about half of vulnerable households have some kind of consumer credit and these loans represent a larger threat to financial stability when associated with mortgages.

where $DC_{i,t}$ is a dummy variable equal to one if household i has a consumer loan in year t and zero otherwise, $DM_{i,t-1}$ is a dummy variable equal to one if household i has a mortgage loan in year $t-1$ and zero otherwise, $Dy_{i,t}$ is a vector of income quartile dummies, $Dur_{i,t}$ is a vector of household durable consumption dummies.

In the second step, the change in the total amount of consumer credit $\Delta C_{i,t}$ is forecast running the following regression:

$$\Delta C_{i,t} = \beta_1 GC_t + \beta_2 Dur_{i,t} \quad (4)$$

where GC_t is the growth rate of consumer loans to households in the Italian economy.

Finally, the instalment paid by each household is computed assuming a standard amortization scheme.

Regarding income projections, we rely again on the approach presented in Michelangeli and Pietrunti (2014). Households are differentiated according to their income class. For each income class, the parameters of the income process (mean and variance) are estimated using historical microeconomic data and households' income can be diverse reflecting different income realizations. The process for the growth of disposable income y for each class j is given by:

$$log(y_{j,t}) - log(y_{j,t-1}) \sim N(\mu_j, \sigma_j) \quad (5)$$

The debt and income growth generated by the model is then required to be consistent with the growth in household debt and nominal income from macroeconomic projections.

4.2 Consumption projections

To assess the impact of a carbon tax on households' financial vulnerability in a static setup, Faiella et al. (2022) propose to reduce households' disposable income by a proportion corresponding to the increase in total expenditure driven by the carbon tax, taking into account the energy demand price elasticity for different subgroups of the population. They build on the work by Faiella and Lavecchia (2021b), who compute the price elasticity to electricity, natural gas and transportation fuel prices, and then derive the increase in expenditure induced by the introduction of a carbon tax.

Differently from Faiella et al. (2022), we aim to assess how the change in energy prices, induced by a combination of supply and demand factors in 2021 and the Russian invasion of Ukraine in 2022, affected households' financial vulnerability, via higher energy expenses. To this end, we need to project household consumption evolution. To do so, we start from each *i-th* household consumption in period *t-1*, $c_{i,t-1}$; we multiply this by the annual growth recorded for the stratum s to which household i belongs, $g_{s,t}$:[29]

$$c_{i,t} = c_{i,t-1}(1 + g_{s,t}) \tag{6}$$

We then aggregate consumption over the entire population and scale it by an adjustment factor, γ, to make sure that changes in aggregate consumption stemming from the model match those coming from macroeconomic projections resulting from the proprietary model of the Bank of Italy.

At this stage, each household in our model has its own debt, income and consumption over the simulation period.

4.3 Households vulnerability in presence of energy price shocks

In this subsection, we put together all the pieces so far elaborated. We take the changes in expenditure induced by the higher energy prices for each stratum, and join this information with the Bank of Italy's 2020 SHIW microdata, using stratum as the merging key.

We then assume that households' available income is modified as a consequence of the change in total expenditure triggered by the shock in energy prices. The new household income will be different across households as it will depend on their energy elasticities and consumption levels and how those could change in response to the shock. To account for energy price changes in the scenario ϵ_s (see Table 1), let income (gross of financial charges and net of imputed rents) y

[29]For the first year of analysis, 2021, we use the average growth of total consumption per stratum from the HBS. For the other two years of simulation, we use the average growth per stratum between 2016 and 2019.

of household i belonging to stratum j be modified as follows:

$$y_{i,\tilde{t},\epsilon_s} = y_{i,t} + c_{i,t}(1 - d_{i,t,\epsilon_s}) \tag{7}$$

where $c_{i,t}$ is household consumption, and d_{i,t,ϵ_s} is an adjustment factor equal to the ratio of total consumption after and before the change in energy price. In case there is no energy price shock, d_{i,t,ϵ_s} goes to 1 and $y_{i,\tilde{t},\epsilon_j}$ equals $y_{i,t}$.

Against these assumptions, the indicator for household financial vulnerability, $VHH_{i,t}$, which now accounts for the effects on income of higher energy prices, is defined as follows:

$$VHH_{i,t} = \begin{cases} 1 & \text{if } L_{i,t}/y_{i,\tilde{t},\epsilon} > 0.3 \\ & \text{and } y_{i,\tilde{t},\epsilon} < median(y_{i,\tilde{t},\epsilon}) \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where $L_{i,t}$ is household i total loan instalment (given by the sum of mortgage and consumer credit instalments) in year t, and $median(y_{i,\tilde{t},\epsilon})$ is the median value of equalized income in the population in period t, adjusted to take into account the effect of the energy price change.

5 Static model results

To kick off our exercise, we run a series of simulations under the static balance sheet assumption, i.e. we focus on the characteristics of the households in the year of the last available SHIW (i.e. 2020). We start by defining a baseline scenario, where there are no energy price shocks. We then take on board such shocks by applying the cumulative energy price changes (in absolute values) observed for the period 2020-22 (see the first row of Table 1). We repeat the exercise in two cases: in the first one, households do not adjust their consumption bundle to price increases and keep consuming the same quantities of energy goods despite the price shock, i.e. we assume no price elasticity. In the second case, households instead change their consumption habits to fight back against price hikes, i.e. using previously estimated price elasticities per stratum (see Section 3.2 and Table 2).

Given the lack of more granular information on prices, we assume that all households faced the same energy price increases according to scenario ϵ_s, which is likely not the case in reality. This renders the results of the exercise an upper bound for households' vulnerability since, as we have seen above in Section 3.1, the overwhelming majority of consumers have multi-year contracts. However, we still believe that our exercise remains useful as, by definition, stress tests are directed at assessing the resilience of the financial sector to very negative shocks.

5.1 Case 1 (no elasticity): households not re-adjusting their consumption after the shock

We consider first the case where energy demand price elasticity equals zero, i.e. households do not change (directly) the quantity of energy consumed despite the jump in energy prices. Therefore, households' energy expenditure increases after the shock by an amount equal to the price change multiplied by the 2020 consumption level. Panel (a) in Figure 1 and the first two Columns of Table 3 show expenditure and income variations. The dots in Figure 1 represent the average ratio between total household energy consumption expenses after and before the energy shock, $\bar{d}_{t,\epsilon_s}$, while the bars show the adjusted average disposable income taking into account the eventual re-composition of household expenses occurring as a consequence of the energy price shock. Averages are computed across different simulations.

In the baseline scenario, by construction, nothing changes. Expenses are the same before and after the shock and the ratio $\bar{d}_{t,\epsilon_s}$ equals 1. Consequently, the average household disposable income, which can be used for debt repayments, is equal to 26,882 euros. We compare these results under three different energy price scenarios (see Table 1), i.e. price variations under the regulated market regime, as measured by the NIC Index or as assessed by Eurostat.

In the scenarios featured by the NIC index or the regulated market consumption expenses go up the most after the shock (about 7.6 - 7.8 per cent). The higher expenses translate into a pronounced drop in annual disposable income, which decreases to 25,433 - 25,396 euros (corresponding to a slightly higher than 5 per cent decline). In the case of the Eurostat price variations, the increase in expenditure is more contained, but still not negligible, and just shy of 3 per cent. Disposable income drops to 26,334 euros, a 2 per cent decrease.

Table 3 (Columns 3 and 4) and Panel (b) in Figure 1 show the impact of energy price changes on households' financial vulnerability in the baseline scenario and under the aforementioned three alternative scenarios. In the baseline scenario, the share of vulnerable households equals 1.45 per cent and the debt that they hold (debt at risk) corresponds to 9.19 per cent of total household debt.

The decrease in disposable income, by limiting the available financial resources that can be used to service the debt, has a negative impact on financial vulnerability. The highest increase in fragility is recorded under the NIC and regulated market scenarios. The share of vulnerable households and the debt at risk reach, respectively, 1.83 and 10.72 per cent (an increase with respect to the baseline by 26 and 17 per cent, respectively). While increasing, financial vulnerability remains at levels still well below those recorded in the aftermath of the global financial crisis.

In the case of Eurostat the smaller drop in disposable income translates into a more limited increase in financial vulnerability. The share of vulnerable households reaches 1.62 per cent and the debt at risk grows to about 10.35 per cent, recording an expansion of about 12 per cent.

The relatively significant surge (evaluated in percentage terms) in debt at risk under all the above-considered scenarios does not square very well with evidence coming from supervisory reports, according to which household defaults remain overall low and the increase in energy prices does not seem to have driven a drastic deterioration of financial conditions (see Bank of Italy 2023).

5.2 Case 2 (with price elasticity): households re-adjusting their consumption after the shock

We now consider a far more realistic, yet less studied, case where, in the face of an energy price shock, households re-adjust their consumption depending on their price elasticity. To this end, we exploit the elasticity estimated at the group (stratum) level in Section 3 and Table 2.

Aggregate results. Panel (a) in Figure 2 shows how household expenses and disposable income change after the energy price shock when energy price elasticities are assumed to be different from zero. Table 4 reports the underlying estimates. As above, in the baseline scenario, consumption expenses and disposable income remain unaltered in response to energy price shocks as the latter are assumed not to affect expenditure.

However, when we allow for such shocks to properly kick in, households respond in a significantly different way with respect to the case without elasticity. To curb expenditure, they cut their energy use and forgo part of their welfare; in doing so, they limit the impact of the price hikes on their budgets and, consequently, the reduction in disposable income.

In the case of the NIC Index (i.e. when energy prices record the highest jump), households do not face a proportional increase in expenses since some of them choose to modify the quantities of electricity and natural gas used to cope with the shock (i.e. they sacrifice their welfare to limit the impact on their budget). For instance, they can lower the heating temperature or the number of hours of activity of appliances such as heat pumps or air conditioners.

As a consequence, the ratio between total expenditure *after* the energy shock and expenses *before* is barely changed and close to 1 (the ratio $\bar{d}_{t,\epsilon_s}$ equals 1.004) against 1.076 in the case of null elasticity. Hence, disposable income decreases only by a limited amount (around 100 euros).

The effects on income and expenditure exploiting the regulated market are the largest, although still significantly lower than in the case without elasticity. Households' overall expenses rise by about 1.4 per cent (vs 7.8 per cent in the null elasticity case) and annual disposable income decreases by about 280 euros.

In the case of Eurostat, which recorded the smallest price increase, the ratio between after and before expenses goes up to 1.007 (1.029 in the scenario with null elasticity), while the disposable income plummets to 26,754, with a decrease of around euros 130.

It is worth underlining that the mechanism triggering the income reduction is rather different in the case of the NIC index and in that of Eurostat. In the former case, households face the heftiest increase in prices and to cope with it re-adjust consumption to maintain disposable income. In the latter, price spikes are manageable, consumption goes up slightly more than in the NIC case. Disposable income drop remains still contained.

In terms of channels at play, the energy price shock does not affect directly household loan instalments and thus its impact on financial vulnerability occurs only through the decrease in income.

When we consider prices measured by the NIC Index, the share of financially vulnerable households slightly increases to 1.46 per cent and debt at risk reduces to 9.03 per cent. If we consider the variations as measured by the regulated market, the lower disposable income translates into a higher vulnerability, with respect to both the share of vulnerable households and their debt: the former increases significantly to 1.58 per cent, while the latter increases to 10.32 per cent, though still lower compared to the null elasticity case (1.83 and 10.72, respectively).

In general, the largest increase in vulnerability occurs when the energy price upsurge is not enough to trigger a sizable reduction in household energy consumption. Under these circumstances, households decide to only slightly reduce their energy consumption and foot the higher energy bill; greater energy expenses eat in disposable income and financial vulnerability raises as a consequence; on the opposite, debt at risk slightly decreases in the case of the heftiest increase in energy prices (the NIC index) as this induces households to revisit their consumption choices: household energy demand barely increases, therefore energy expenses as well as disposable income are almost unaltered. This contains the impact on financial vulnerabilities within the household sector. At the same time, households' welfare can suffer a severe blow.

Heterogeneity results. Tables 5 and 6 show heterogeneity in terms of expenses adjustment, disposable income, the share of vulnerable households and debt at risk along different dimensions. For the sake of simplicity, we will forgo the (unrealistic) case of no price elasticity and we will use the previously estimated price elasticities.

Concerning the geographical area, in the baseline scenario, households in the South have by far the lowest disposable income and the highest vulnerability, both in terms of share of households and debt at risk. Under the three scenarios considered, those households adjust their quantity consumed less than households in other geographical areas. The ratio between after/before expenses is close to 1 but always higher than in the other parts of Italy.

This leads to a slightly more pronounced drop in income available for debt repayments (between 130 and 300 euros) but with only limited effects on their financial vulnerability. After the price shock, such households are still able to maintain their ability to repay their loans. Households in the North did not face a significant increase in financial vulnerability either, but this occurred at the cost of a more marked welfare reduction.

As for the number of household members, we observe that financial vulnerability in the baseline scenario is lower among households with two components. If the energy price shock is contained, as for instance the one measured by the regulated market, these households are the ones that are less willing to modify their consumption quantity and thus they experience the largest increase in debt at risk.

Focusing on age, older households have by far the lowest income level. From a financial perspective, though, the share of those households that are vulnerable is rather limited, but they have still a non-negligible fraction of debt at risk. In the face of an energy price shock, they appear to be less able to modify their consumption (for instance, they cannot further reduce the heating in their house). If the increase in energy prices is manageable, they maintain their consumption, disposable income is consequently reduced and debt at risk goes up; if, instead, the price surge is too high, they are forced to re-balance expenses and obtain additional disposable income.

6 Dynamic model results

6.1 Baseline model: macroeconomic drivers

In this Section, we assess how household financial vulnerability changes in a dynamic model taking into account the evolution of macroeconomic variables, too. As a baseline scenario, we use the latest projections of the Bank of Italy's microsimulation model (see Bank of Italy 2023) in which the level of households' vulnerability decreases in the two years 2021-2022 and records a slight increase in 2023 (Figure 3). The trend reflects a sustained recovery in nominal disposable income, which grows by around 4 per cent year-on-year in 2021 and in 2022 accelerates to 6.5

per cent.[30] The increase in income is higher than that of both mortgages, which are expected to slow down sharply in 2023, and consumer credit. In 2023 the higher household vulnerability would therefore be mainly attributable to the sharp and rapid increase in loan rates following the change in monetary policy stance implemented to fight the inflation spike.

6.2 Case 1 (no elasticity): households not re-adjusting their consumption after the shock

We consider a dynamic model where households' income and debt evolve over time reflecting macroeconomic developments, but with households not readjusting their quantity of energy consumed following the yearly price increases. As shown in Figure 4 and Table 7, in 2021, across the different scenarios considered, changes in disposable income with respect to baseline are contained (between 60 and 320 euros). This reflects the limited increase in energy prices and the consequent limited additional expenses to maintain constant the quantity consumed. On the opposite, the increase in energy expenses is quite pronounced in 2022, ranging from 2.4 to 5.5 per cent across scenarios. Households' disposable income dropped markedly, up to 1,150 euros. Concerning financial vulnerability, in 2022 debt at risk decreases with respect to 2020, across the three scenarios considered, but debt at risk raises with respect to the previous year (i.e. with respect to 2021). The increase turns out to be stronger when the energy price upsurge is measured by the NIC Index, but, under any scenarios, we observe the same dynamics. This non-monotonic evolution of the debt at risk is inconsistent with the one for the new rate of non-performing loans, which continued to decrease over the biannual period, highlighting that some important readjustment has taken place in real data.

[30]Starting from 2021, households' income has also been propped up by government's measures aimed at helping most-in-need households ease pressure on their balances stemming from the energy price surge.

6.3 Case 2 (with price elasticity): households re-adjusting their consumption after the shock

In this Section we assume that households re-adjust their yearly consumption, once faced with the energy price shock.

Aggregate results. As shown in Table 1, energy price variations are overall contained between 2020 and 2021 and are practically unchanged when they are computed using the Eurostat price measure. As a consequence, when the latter is employed, almost all households choose to accommodate the price raise with slightly higher expenses, which bears a negligible impact on disposable income (decreasing on average by less than 20 euro; Panel (a) of Figure 5 and Table 8). In the cases of the NIC Index or regulated market, larger price variations are associated with more marked expenses and a deeper, but still moderate, decline in average income (around 100 euros).

Energy price variations are instead more pronounced over the period 2021-2022. Under any scenarios considered, households increase their average consumption expenditure in the range of 0.7-1.3 per cent. Notwithstanding differences in the extent of price hikes across scenarios, price spikes seem to have a similar impact on total expenditure; this suggests that households can afford to directly accommodate price-driven expenditure rises up to a threshold, above which they are forced to revisit consumption habits. Hence, it appears that the price-triggered expenditure increase in the NIC and regulated market scenarios - which are more than twice as big as Eurostat's (see Table 1)- drives a more pronounced consumption correction. The ensuing decrease in disposable income is comparable across scenarios and corresponds to around 300 euro.

Household vulnerability does not go up following the rise in energy prices. Throughout any scenarios the share of vulnerable households appears to be the same or smaller than that prevailing in the baseline (Panel (b) of Figure 5), suggesting that the fall in income in general was more than compensated by the expected softening in credit expansion. As for the share of debt at risk, this is always lower than in the baseline. This result confirms that indebted households, more than others, adjust their consumption patterns in such a way as to keep a level of disposable income as unchanged as possible to be used also for debt repayments. Again, while the energy price increase does not lead to higher financial vulnerability, household welfare could have suffered a blow as a consequence of the cut in energy consumption. The result on financial vulnerability is very much in line with the evidence from the rate of new non-performing loan ratio based on supervisory reports (Figure 3) which was not the case under the (unrealistic albeit very common) assumption of no price elasticity. The debt at risk is an indicator with similar dynamics to the new non-performing loan ratio and can be used to forecast the evolution of vulnerability.

Heterogeneity results. Tables 9 and 10 show the results for the dynamic models by considering the heterogeneity across the three dimensions already overlooked above. Overall, we find a confirmation of the aggregate results in the dynamic setting: against a backdrop of energy price shocks having a more marked impact in 2022, the higher the inflation shock, the more likely households re-adjust their consumption habit; this happens if the shock pushes total expenses above a threshold over which households cannot accommodate price increases. As a consequence of the consumption correction, disposable income is hit less. In general, taking on board consumption re-adjustment - which reflects the coming into play of the energy price elasticities - brings about limited effects in financial vulnerability. With respect to any of the heterogeneity dimensions considered, the energy price changes overall have a homogeneous impact.

Looking at households differentiated by the initial level of vulnerability (Table 11), vulnerable households readjust their consumption up to 1.4 per cent, a change similar to those recorded by other households, much less than the actual price hikes. Nevertheless, given their lower consumption level, the ensuing decrease in disposable income is more contained than that of the non-vulnerable households, and their ability to pay remains mostly unaffected.

Projections for 2023. In this Section, we aim to assess the impact of energy price changes in 2023. However, the availability of energy price data available is limited. The unique source that we can exploit is from the regulated market which provides information for both electricity and gas until June 2023. According to this source, energy prices declined in the first semester of 2023 with respect to 2022. The change in absolute terms equals -0,1 €/kWh for electricity and -10,0 €/Gj for gas. The lower energy prices translate into a lower consumption expenditure: though prices have fallen households have not increased much their quantity consumed. This leads to higher income available for servicing debt and slightly lower financial vulnerability (Panel A, Table 12).

Given that available data refer only to the first semester and are provided by a unique data source, we consider two alternative energy price changes for 2023, which act both as a robustness check and as a stress test exercise. We first exploit a smaller change in energy prices, similar to the one recorded in 2020-21; then we apply a bigger price increase, in line with that occurring in 2021-22. In both cases, household expenditure increases and disposable income decreases, but the share of vulnerable households and the debt at risk show a mild reduction with respect to baseline in 2023 (Panels B and C, Table 12), in line with the mechanics described for 2022. This reaffirms that macro variables - other than energy prices - drive the evolution of vulnerability.

7 Conclusions

During 2021, retail prices of electricity and natural gas increased significantly owing to a mismatch of supply and demand, further fuelled by the Russian invasion of Ukraine in February 2022. The price surge jeopardized households' welfare and financial soundness, especially in countries like Italy, where prices more than doubled in a short time.

We have developed a microsimulation model to evaluate the impact of the upsurge in energy prices on households' financial vulnerability. This paper builds on previous works of Michelangeli and Pietrunti (2014); Attinà et al. (2020); Faiella and Lavecchia (2021b) and Faiella et al. (2022). For the period 2020-2022, within both a static and a dynamic framework, we show that by not taking into account behavioural responses (i.e. assuming price inelasticity, a common assumption in the literature), households' financial vulnerability may be significantly overestimated. Conversely, by taking energy demand price elasticities into due account along with the evolution of the relevant macro variables, we show that the increase in the number of vulnerable households (and their associated indebtedness) is comparable to the increase in a scenario where energy prices do not change. This is because households readjust their energy consumption levels (i.e., they trim their use of electricity and heating) to maintain a constant level of disposable income, so it can be used to service their debt. At the same time, this is not a free lunch. Households forgo thermal comfort to keep within their budget constraints. In 2023, irrespective of the extent of energy price changes, households' vulnerability will, again, be driven by a number of macroeconomic variables (i.e. interest rates and GDP). We can then conclude that, if the energy price change did not lead to higher financial vulnerability, it could cause an increase in households' energy poverty (Faiella and Lavecchia, 2021a; AA.VV., 2023), since a number of households have cut their energy consumption (heating, electricity) to maintain a constant level of disposable income.

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Tables and figures

Table 1 Cumulated price variations (2020-2022)

	Electricity			Natural gas		
Data source:	Regulated market	NIC Index	Eurostat	Regulated market	NIC Index	Eurostat
Period	(1)	(2)	(3)	(4)	(5)	(6)
			A. Percentage variations			
2020-22	172	142	46	92	109	47
2020-21	31	15	4	22	21	6
2021-22	108	110	40	57	74	38
			B. Absolute variations			
2020-22	0.31	0.60	0.11	15.8	48.9	10.9
2020-21	0.05	0.29	0.01	3.8	28.2	1.4
2021-22	0.25	0.32	0.10	12.0	20.7	9.4

Notes: results are in percentage points for cumulated variations, €/kWh for electricity and €/Gj for natural gas in the case of absolute variations.
The absolute variations for the NIC use Eurostat as base.

Table 2 Price elasticities of energy demand at stratum level

	Electricity		Heating	
Strata*	$\hat{\beta}_s$	$\hat{\sigma_\beta}$	$\hat{\gamma}_s$	$\hat{\sigma_\gamma}$
102	-0.42	0.28	-0.97	0.20
103	-0.51	0.15	-0.69	0.14
105	-0.76	0.23	-0.99	0.19
106	-0.51	0.15	-0.90	0.15
107	-0.38	0.17	-0.63	0.12
108	-0.55	0.13	-0.66	0.12
109	-0.62	0.18	-0.98	0.19
110	-0.45	0.16	-1.00	0.14
111	-0.28	0.19	-0.99	0.16
202	-0.24	0.21	-1.00	0.19
203	-0.14	0.15	-0.89	0.16
205	-0.57	0.19	-0.83	0.18
206	-0.27	0.15	-0.86	0.16
207	-0.26	0.12	-0.59	0.13
208	-0.27	0.14	-0.54	0.12
209	-0.86	0.24	-1.07	0.20
210	-0.30	0.16	-1.07	0.17
211	-0.40	0.23	-1.19	0.19
302	-0.25	0.19	-0.85	0.17
303	-0.30	0.16	-0.96	0.14
305	-0.16	0.16	-1.09	0.17
306	-0.18	0.15	-1.00	0.17
307	-0.21	0.13	-0.84	0.18
308	-0.22	0.14	-0.72	0.14
309	-0.23	0.26	-1.15	0.33
310	-0.39	0.24	-0.95	0.20
311	0.17	0.25	-1.07	0.20
402	-0.38	0.15	-0.77	0.13
403	-0.15	0.20	-0.92	0.16
405	-0.21	0.15	-0.53	0.14
406	-0.12	0.17	-1.01	0.17
407	-0.46	0.16	-0.62	0.13
408	-0.49	0.18	-0.81	0.18
409	-1.11	0.33	-1.46	0.27
410	-0.53	0.20	-1.21	0.18
411	-0.16	0.27	-1.34	0.24
average	-0.44	0.02	-0.54	0.02

*Strata x01 and x04 are collapsed into x02 and x05 to preserve a minimum sample size.

Table 3 Static model, case 1 (no elasticity): Aggregate results

	Expenses after/ Expenses before (1)	Disposable income (2)	Share of vulnerable HHs (3)	Debt at risk (4)
baseline	1.000	26,882	1.45	9.19
regulated market	1.078	25,396	1.83	10.72
NIC Index	1.076	25,433	1.83	10.72
Eurostat	1.029	26,334	1.62	10.35

Notes: Column 1 shows households' consumption average change after the energy price shock; Column 2 reports disposable income in euros; Columns 3 and 4 include the share of vulnerable households and their debt at risk in percentage values.

Table 4 Static model, case 2 (with price elasticity): Aggregate results

	Expenses after/ Expenses before (1)	Disposable income (2)	Share of vulnerable HHs (3)	Debt at risk (4)
baseline	1.000	26,882	1.45	9.19
regulated market	1.014	26,600	1.58	10.32
NIC Index	1.004	26,783	1.46	9.03
Eurostat	1.007	26,754	1.47	9.25

Notes: Column 1 shows households' consumption average change after the energy price shock; Column 2 reports disposable income in euros; Columns 3 and 4 include the share of vulnerable households and their debt at risk in percentage values.

Table 5 Static model, case 2 (with price elasticity): Heterogeneity in expenses and disposable income

	Expenses after/Expenses before			Disposable income		
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Geographical area					
	North	Center	South	North	Center	South
baseline	1.000	1.000	1.000	31,161	28,151	20,094
regulated market	1.012	1.013	1.018	30,886	27,875	19,798
NIC Index	1.000	1.004	1.011	31,134	28,040	19,898
Eurostat	1.006	1.006	1.008	31035	28029	19960
	B. Number of household components					
	1-2	3	4+	1-2	3	4+
baseline	1.000	1.000	1.000	21,280	33,598	37,186
regulated market	1.014	1.018	1.013	21,045	33,215	36,861
NIC Index	1.001	1.014	1.003	21,246	33,303	37,076
Eurostat	1.006	1.009	1.007	21,184	33,414	37,018
	C. Age classes					
	15-39	40-65	66+	15-39	40-65	66+
baseline	1.000	1.000	1.000	27,611	30,224	21,803
regulated market	1.014	1.014	1.016	27,326	29,930	21,538
NIC Index	1.005	1.005	1.003	27,487	30,104	21,741
Eurostat	1.007	1.007	1.006	27,472	30,082	21,699

Notes: All estimates computed using demand price elasticity at stratum level. Columns 1-3 show households' consumption average change after the energy price shock (in percentage points). Columns 4-6 report disposable income (in euros).

Table 6 Static model, case 2 (with price elasticity): Heterogeneity in financial vulnerability

	Share of vulnerable households			Debt at risk		
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Geographical area					
	North	Center	South	North	Center	South
baseline	1.37	1.33	1.62	8.86	6.00	16.51
regulated market	1.44	1.75	1.67	9.16	9.85	16.91
NIC Index	1.37	1.22	1.72	8.85	5.12	16.91
Eurostat	1.40	1.33	1.67	8.88	6.00	16.91
	B. Number of household components					
	1-2	3	4+	1-2	3	4+
baseline	0.91	2.16	2.34	8.38	9.87	9.45
regulated market	1.08	2.34	2.34	10.85	10.90	9.45
NIC Index	0.91	2.23	2.34	7.85	10.07	9.44
Eurostat	0.94	2.23	2.34	8.44	10.07	9.45
	C. Age classes					
	15-39	40-65	66+	15-39	40-65	66+
baseline	2.47	1.90	0.39	10.42	9.12	9.78
regulated market	3.25	1.94	0.41	11.56	9.92	11.98
NIC Index	2.31	1.98	0.37	10.73	8.92	9.37
Eurostat	2.47	1.94	0.41	10.53	9.13	9.84

Notes: All estimates computed using demand price elasticity at stratum level. The share of vulnerable households and the debt at risk are in percentage values.

Table 7 Dynamic model, case 1 (no price elasticity): Aggregate results

	2020 (1)	2021 (2)	2022 (3)
A. Expenses after /Expenses before			
baseline		1.000	1.000
regulated market		1.016	1.049
NIC Index		1.011	1.055
Eurostat		1.003	1.024
B. Disposable income			
baseline	26,880	27,884	29,652
regulated market	26,880	27,565	28,635
NIC Index	26,880	27,656	28,499
Eurostat	26,880	27,820	29,151
C. Share of vulnerable households			
baseline	1.45	1.62	1.80
regulated market	1.45	1.54	1.81
NIC Index	1.45	1.55	1.85
Eurostat	1.45	1.53	1.74
D. Debt at risk			
baseline	9.30	8.18	7.90
regulated market	9.30	8.25	8.62
NIC Index	9.30	8.18	8.75
Eurostat	9.30	8.07	8.16

Notes: Panel A shows households' consumption average change after the energy price shock; Panel B reports disposable income in euros; Panels C and D include the share of vulnerable households and their debt at risk in percentage values.

Table 8 Dynamic model, case 2 (with price elasticity): Aggregate results

	2020 (1)	2021 (2)	2022 (3)
A. Expenses after /Expenses before			
baseline		1.000	1.000
regulated market		1.004	1.013
NIC Index		1.005	1.012
Eurostat		1.001	1.006
B. Disposable income			
baseline	26,880	27,884	29,652
regulated market	26,880	27,805	29,368
NIC Index	26,880	27,776	29,389
Eurostat	26,880	27,864	29,517
C. Share of vulnerable households			
baseline	1.45	1.62	1.80
regulated market	1.45	1.55	1.72
NIC Index	1.45	1.55	1.72
Eurostat	1.45	1.62	1.71
D. Debt at risk			
baseline	9.30	8.18	7.90
regulated market	9.30	8.09	7.88
NIC Index	9.30	8.18	7.87
Eurostat	9.30	8.06	7.84

Notes: Panel A shows households' consumption average change after the energy price shock; Panel B reports disposable income in euros; Panels C and D include the share of vulnerable households and their debt at risk in percentage values.

Table 9 Dynamic model, case 2 (with price elasticity): Heterogeneity in expenses and disposable income

	Expenses after/Expenses before			Disposable income		
	(1)	(2)	(3)	(4)	(5)	(6)
	Geographical area					
	North	Center	South	North	Center	South
	2020					
baseline				31,161	28,138	20,094
	2021					
baseline	1.000	1.000	1.000	32,341	29,201	20,813
regulated market	1.003	1.004	1.005	32,262	29,126	20,735
NIC Index	1.003	1.005	1.010	32,261	29,090	20,638
Eurostat	1.001	1.001	1.001	32,321	29,182	20,794
	2022					
baseline	1.000	1.000	1.000	34,414	31,063	22,097
regulated market	1.012	1.012	1.016	34,131	30,785	21,806
NIC Index	1.010	1.011	1.016	34,168	30,807	21,806
Eurostat	1.006	1.006	1.008	34,279	30,934	21,958
	Number of household components					
	1-2	3	4+	1-2	3	4+
	2020					
baseline				21,280	33,598	37,186
	2021					
baseline	1.000	1.000	1.000	22,080	34,858	38,543
regulated market	1.004	1.004	1.004	22,016	34,758	38,446
NIC Index	1.003	1.012	1.007	22,036	34,589	38,351
Eurostat	1.001	1.001	1.001	22,065	34,832	38,517
	2022					
baseline	1.000	1.000	1.000	23,488	37,066	40,969
regulated market	1.013	1.016	1.012	23,246	36,695	40,640
NIC Index	1.011	1.017	1.011	23,286	36,672	40,649
Eurostat	1.006	1.008	1.007	23,383	36,877	40,794
	Age classes					
	15-39	40-65	66+	15-39	40-65	66+
	2020					
baseline				27,611	30,218	21,803
	2021					
baseline	1.000	1.000	1.000	27,970	31,569	22,959
regulated market	1.004	1.004	1.004	27,890	31,486	22,888
NIC Index	1.006	1.006	1.004	27,825	31,409	22,906
Eurostat	1.001	1.001	1.001	27,949	31,547	22,942
	2022					
baseline	1.000	1.000	1.000	29,111	33,572	24,749
regulated market	1.013	1.012	1.015	28,837	33,277	24,475
NIC Index	1.012	1.012	1.013	28,850	33,285	24,515
Eurostat	1.006	1.006	1.006	28,972	33,422	24,632

Notes: Columns 1-3 show household consumption average change after the energy price shock. Columns 4-6 report disposable income in euros.

Table 10 Dynamic model, case 2 (with price elasticity): Heterogeneity in financial vulnerability

	Share of vulnerable households			Debt at risk		
	(1)	(2)	(3)	(4)	(5)	(6)
	Geographical area					
	North	Center	South	North	Center	South
	2020					
baseline	1.37	1.37	1.62	8.86	6.51	16.51
	2021					
baseline	1.46	1.01	2.22	7.36	6.49	16.51
regulated market	1.26	1.02	2.24	7.36	4.40	16.41
NIC Index	1.26	1.09	2.32	7.50	4.36	16.48
Eurostat	1.38	1.00	2.22	7.34	4.34	16.32
	2022					
baseline	1.46	1.31	2.59	6.52	6.90	16.24
regulated market	1.26	1.27	2.64	6.52	4.87	16.39
NIC Index	1.26	1.26	2.69	6.56	4.79	16.32
Eurostat	1.25	1.30	2.61	6.49	4.99	16.16
	Number of household components					
	1-2	3	4+	1-2	3	4+
	2020					
baseline	0.93	2.16	2.34	8.69	9.87	9.45
	2021					
baseline	1.41	2.16	2.20	9.35	9.84	7.36
regulated market	1.24	1.68	2.28	8.98	7.61	7.47
NIC Index	1.27	1.69	2.40	8.98	7.63	7.68
Eurostat	1.33	1.67	2.24	9.00	7.57	7.38
	2022					
baseline	1.53	2.69	2.25	9.68	9.64	6.47
regulated market	1.36	2.22	2.31	9.40	7.50	6.59
NIC Index	1.39	2.22	2.30	9.35	7.52	6.61
Eurostat	1.36	2.21	2.28	9.43	7.43	6.53
	Age classes					
	15-39	40-65	66+	15-39	40-65	66+
	2020					
baseline	2.47	1.92	0.39	10.14	9.59	9.95
	2021					
baseline	1.98	1.92	0.69	8.87	9.14	10.37
regulated market	1.99	2.28	0.42	8.77	7.62	10.09
NIC Index	1.99	2.36	0.43	8.81	7.73	10.14
Eurostat	1.98	2.25	0.58	8.74	7.57	10.08
	2022					
baseline	2.02	2.19	0.86	8.83	8.73	10.50
regulated market	2.17	2.51	0.61	8.81	7.24	10.29
NIC Index	2.11	2.55	0.61	8.81	7.23	10.25
Eurostat	2.08	2.52	0.60	8.77	7.20	10.30

Notes: The share of vulnerable households and the debt at risk are in percentage values.

Table 11 Dynamic model: Heterogeneity in expenses and disposable income by initial level of vulnerability

	Expenses after/Expenses before		Disposable income	
	(1)	(2)	(3)	(4)
	Vulnerability in 2020			
	No	Yes	No	Yes
	2021			
baseline	1.000	1.000	28,153	13,056
regulated market	1.004	1.004	28,075	12,982
NIC Index	1.005	1.007	28,036	12,916
Eurostat	1.001	1.001	28,133	13,037
Changes from baseline	*difference*		*difference in euros*	
regulated market	*0.004*	*0.004*	*-78*	*-75*
NIC Index	*0.005*	*0.007*	*-117*	*-140*
Eurostat	*0.001*	*0.001*	*-20*	*-19*
	2022			
baseline	1.000	1.000	29,978	13,420
regulated market	1.013	1.014	29,693	13,184
NIC Index	1.012	1.013	29,714	13,202
Eurostat	1.006	1.007	29,842	13,299
Changes from baseline				
regulated market	*0.013*	*0.014*	*-286*	*-235*
NIC Index	*0.012*	*0.013*	*-264*	*-217*
Eurostat	*0.006*	*0.007*	*-136*	*-121*

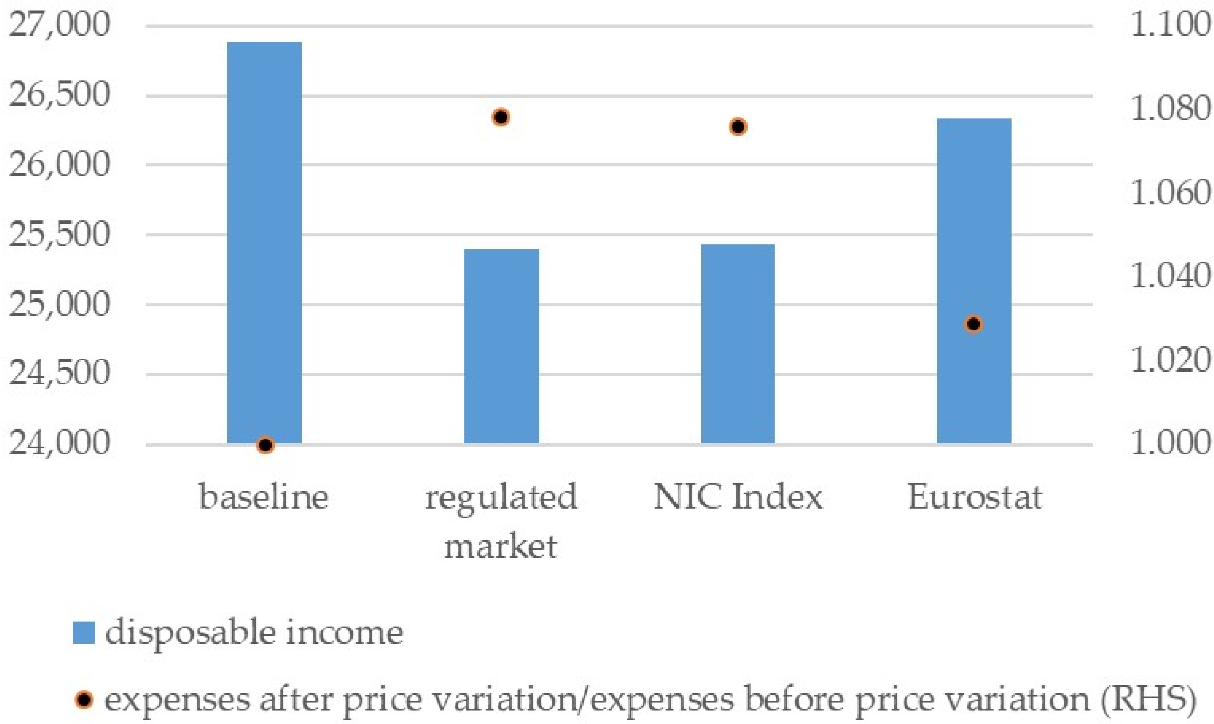
Notes: Columns 1 and 2 show household consumption average change after the energy price shock. Columns 3 and 4 report disposable income in euros.

Table 12 Dynamic model: Projections for 2023

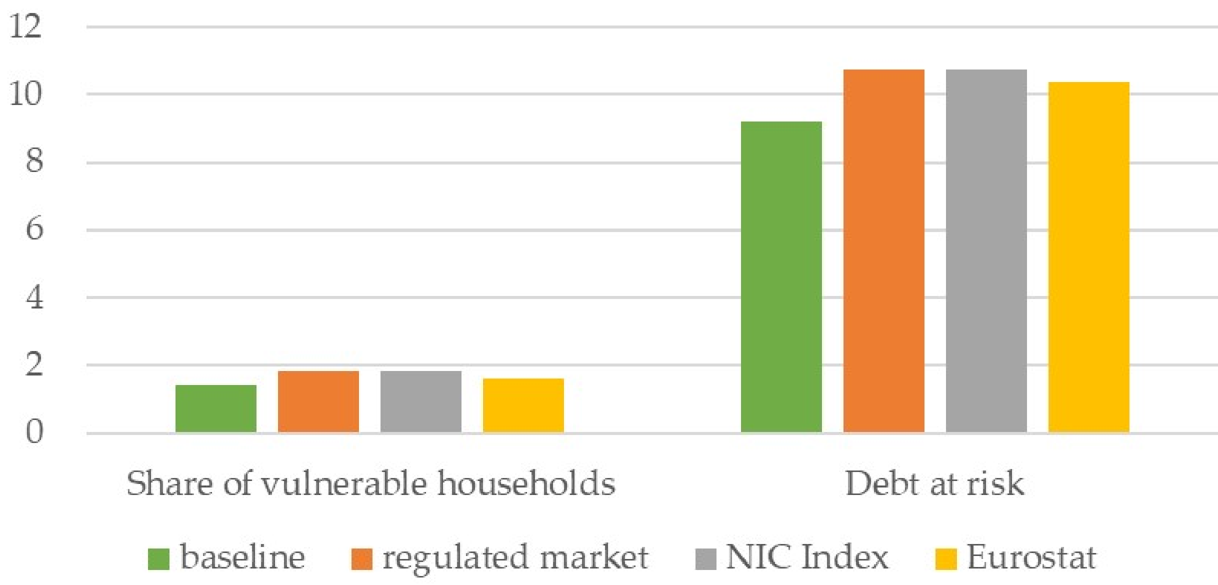
	Expenses after/ Expenses before (1)	Disposable income (2)	Share of vulnerable HHs (3)	Debt at risk (4)
baseline	1.000	30,655	2.47	9.62
	A. Available data (June 2023)			
regulated market	0.986	30,951	2.44	9.38
	B. Low energy price variation (2020-21)			
regulated market	1.004	30,572	2.38	9.55
NIC Index	1.005	30,530	2.41	9.57
Eurostat	1.001	30,634	2.45	9.54
	C. High energy price variation (2021-22)			
regulated market	1.013	30,366	2.42	9.63
NIC Index	1.013	30,388	2.44	9.62
Eurostat	1.006	30,518	2.40	9.61

Notes: Column 1 shows household consumption average change after the energy price shock; Column 2 reports disposable income in euros; Column 3 and 4 include the share of vulnerable households and their debt (debt at risk) in percentage values.

Figure 1 Static model, case 1 (no price elasticity): aggregate results



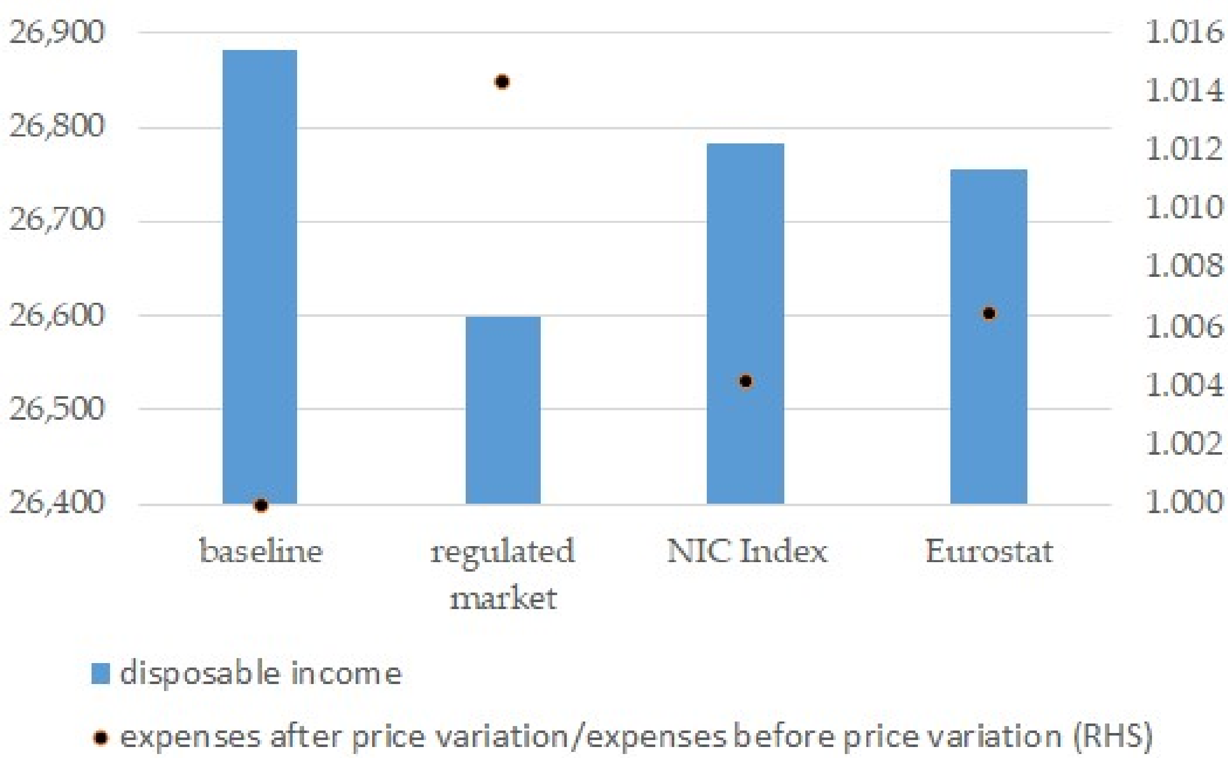
(a) Changes in expenses and disposable income



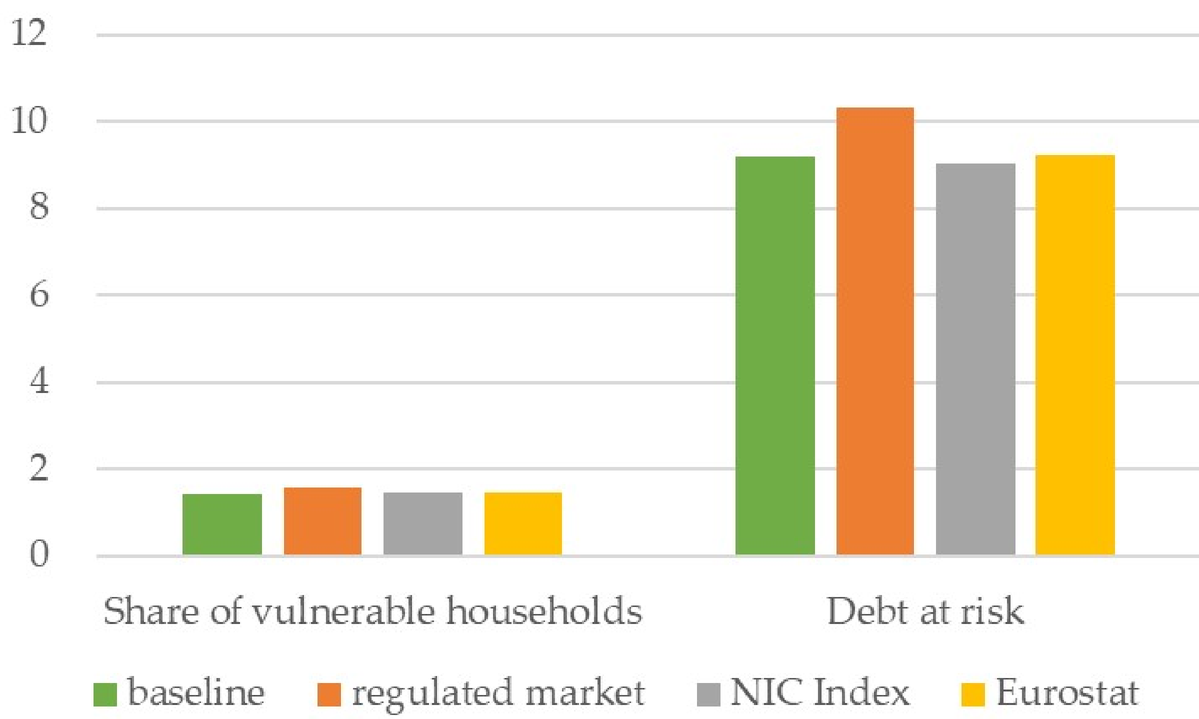
(b) Financial vulnerability indicators

Notes: Panel (a) shows households' consumption and disposable income average change after the energy price shock. Disposable income is in euros. Panel (b) reports the share of vulnerable households and their debt at risk. Results are in percentage values.

Figure 2 Static model, case 2 (with price elasticity): aggregate results



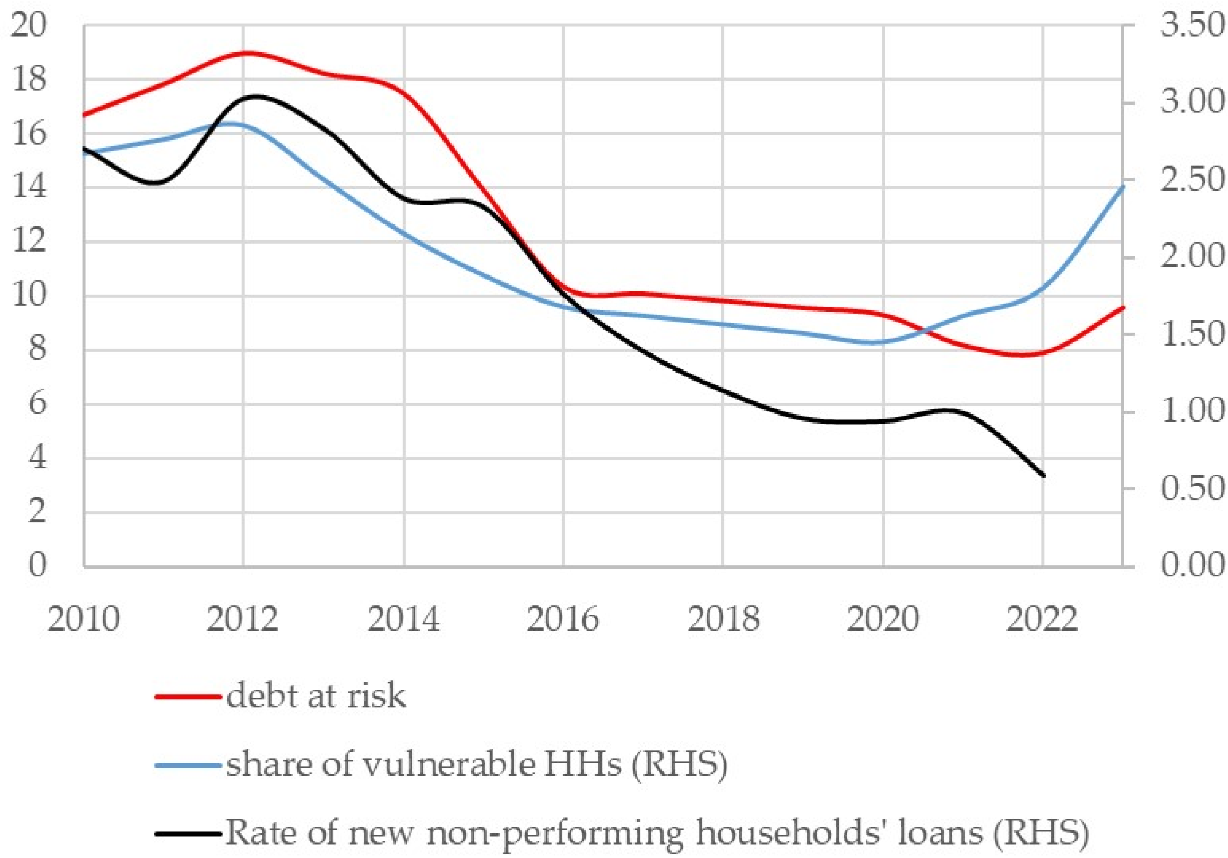
(a) Changes in expenses and disposable income



(b) Financial vulnerability

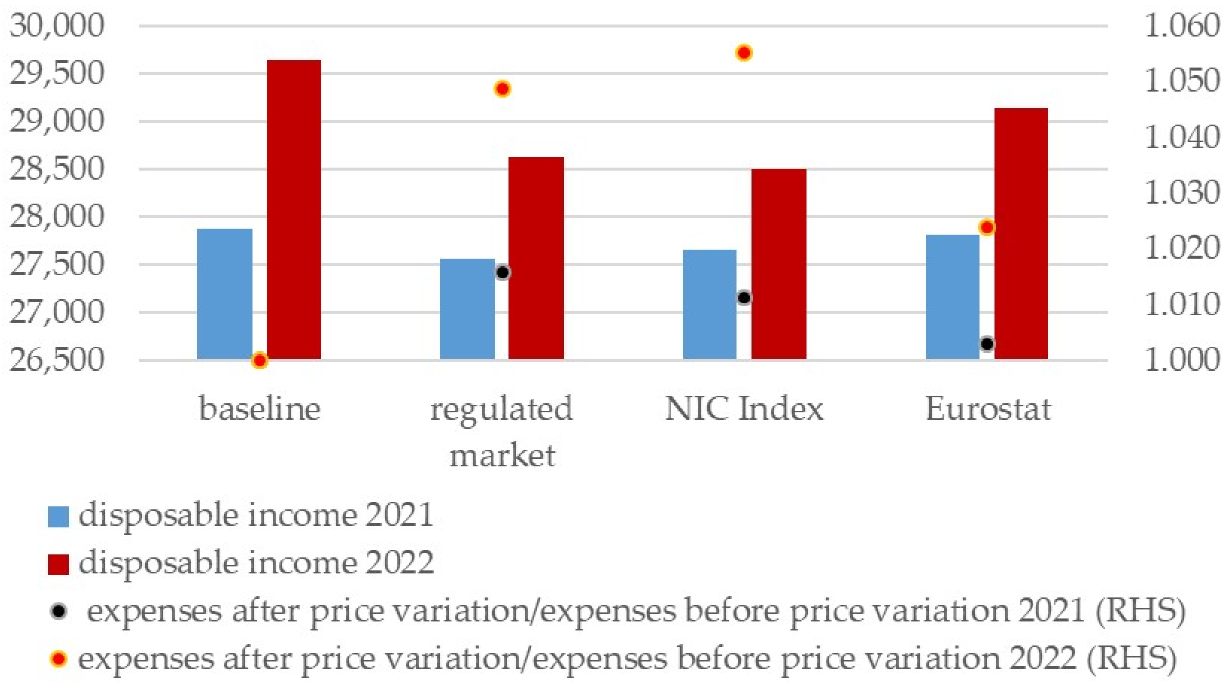
Notes: Panel a) shows how household consumption and disposable income change, on average, after the energy price shock. Panel b reports the share of vulnerable households and their debt at risk. Disposable income is reported in euro, results for Panel b) are reported in percentage values.

Figure 3 Dynamic model: baseline

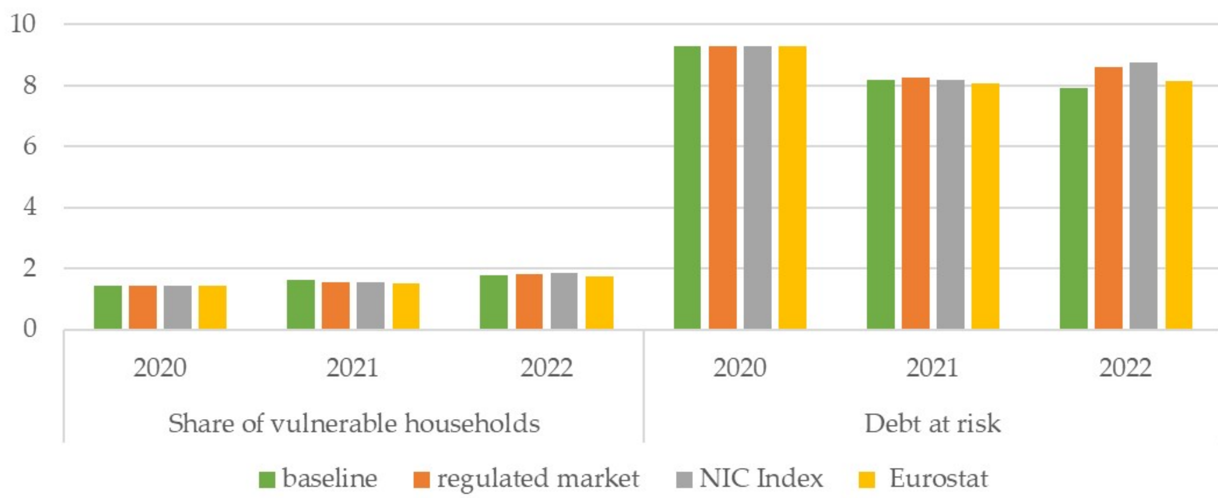


Notes: The figure shows the share of vulnerable households and the debt at risk in the baseline model. The rate of new non-performing households' loans is defined as the ratio of non-performing loans on total household loans at the beginning of the period and it is calculated as an average of the quarters; the ratio is available until 2022.

Figure 4 Dynamic model, case 1 (no price elasticity): Aggregate results



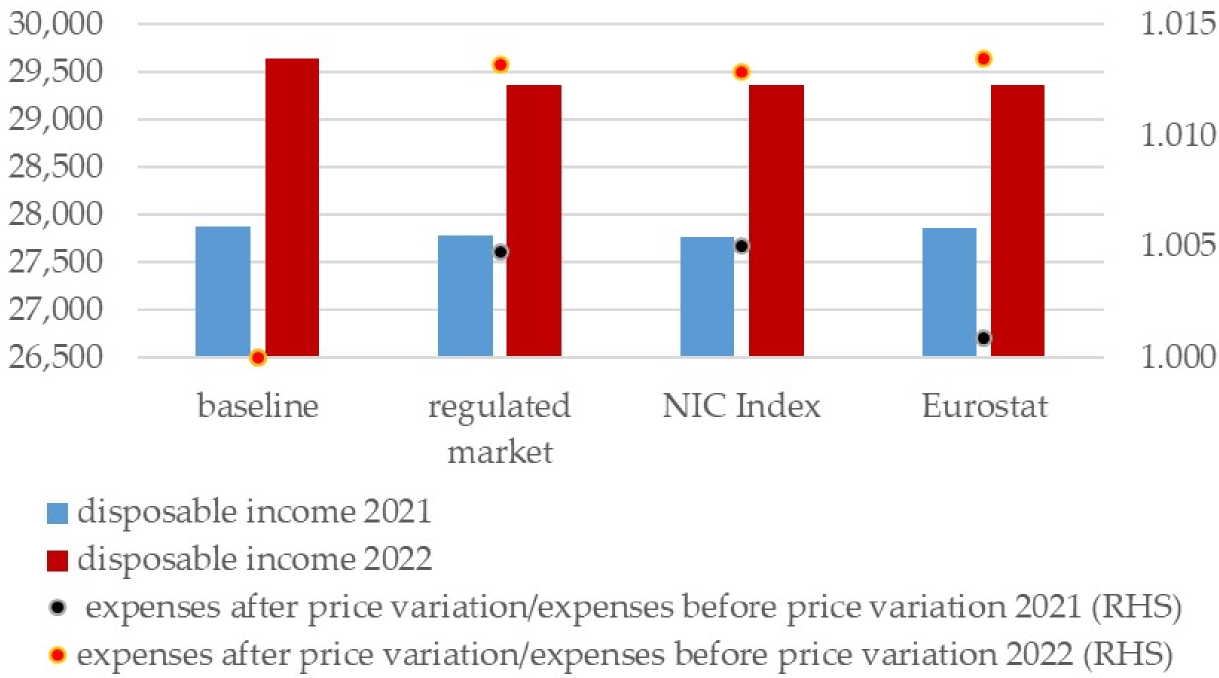
(a) Expenses and income



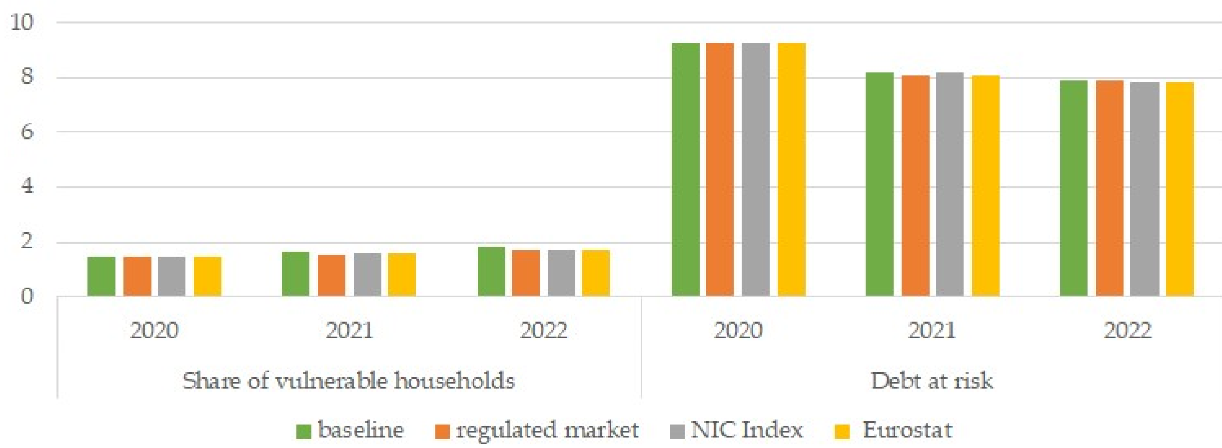
(b) Financial vulnerability

Notes: Panel (a) shows how household consumption and disposable income change, on average, after the energy price shock. Panel (b) reports the share of vulnerable households and their debt (debt at risk). Disposable income is in euro, results for Panel (b) are in percentage values.

Figure 5 Dynamic model, case 2 (with price elasticity): Aggregate results



(a) Expenses and income



(b) Financial vulnerability

Notes: Panel (a) shows how household consumption and disposable income change, on average, after the energy price shock. Panel (b) reports the share of vulnerable households and their debt (debt at risk). Disposable income is in euro, results for Panel (b) are in percentage values.